United States Patent [19]

Werych

[11] **4,246,852**

[45] **Jan. 27, 1981**

[54] **INDUSTRIAL FURNACE WITH CERAMIC INSULATING MODULES**

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[73] Assignee: **General Signal Corporation,** Stamford, Conn.

[21] Appl. No.: **50,547**

[22] Filed: **Jun. 21, 1979**

[51] **Int. Cl.**[3] **F23M 5/00**

[52] **U.S. Cl.** **110/336;** 110/339; 432/247; 266/283

[58] **Field of Search** 110/331, 332, 336, 339; 432/247–249, 252; 266/280, 283, 286

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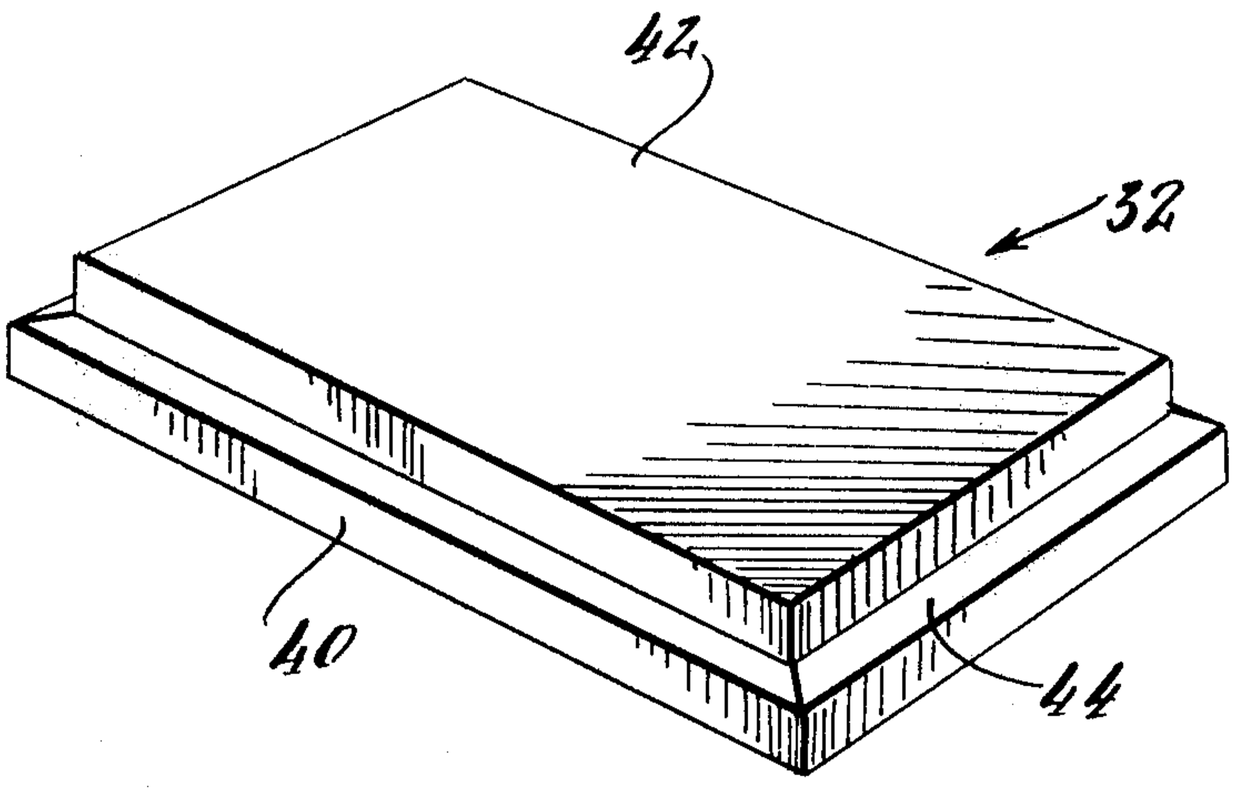
Primary Examiner—Henry C. Yuen

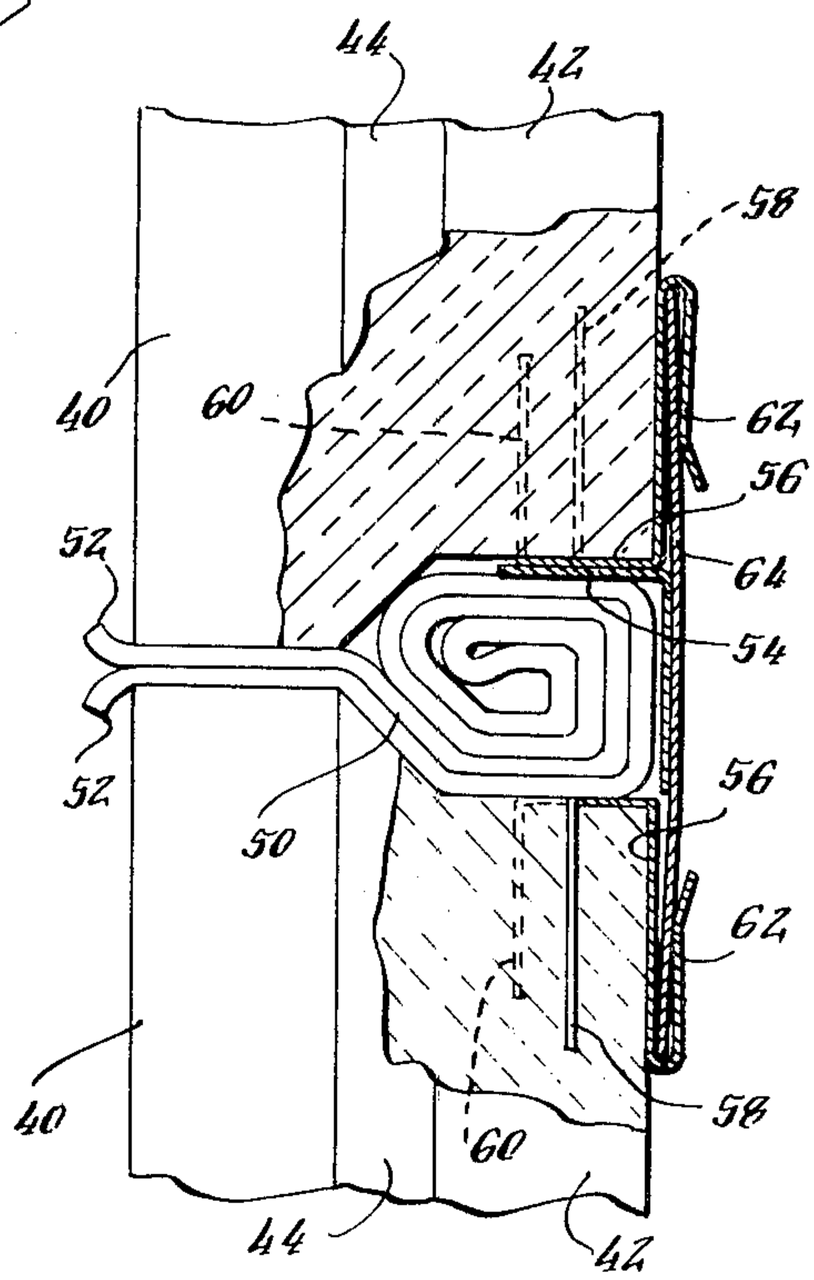
Attorney, Agent, or Firm—Parmelee, Johnson, Bollinger & Bramblett

[57] **ABSTRACT**

An industrial furnace with insulating walls comprising side-by-side pre-formed panels each including a plurality of ceramic insulating modules. The side wall panels include vertical buckstays to which the modules are secured by retainer clips including sharp spikes inserted into side edge surfaces of the insulating modules. Modules with offset stepped side profiles are disclosed, arranged to provide for ready removal of a single module without disturbing adjacent modules. Atmosphere furnace insulation arrangements also are disclosed utilizing ceramic modules secured to the furnace shell by special retainer clips embedded in side edge surfaces of the modules.

8 Claims, 18 Drawing Figures





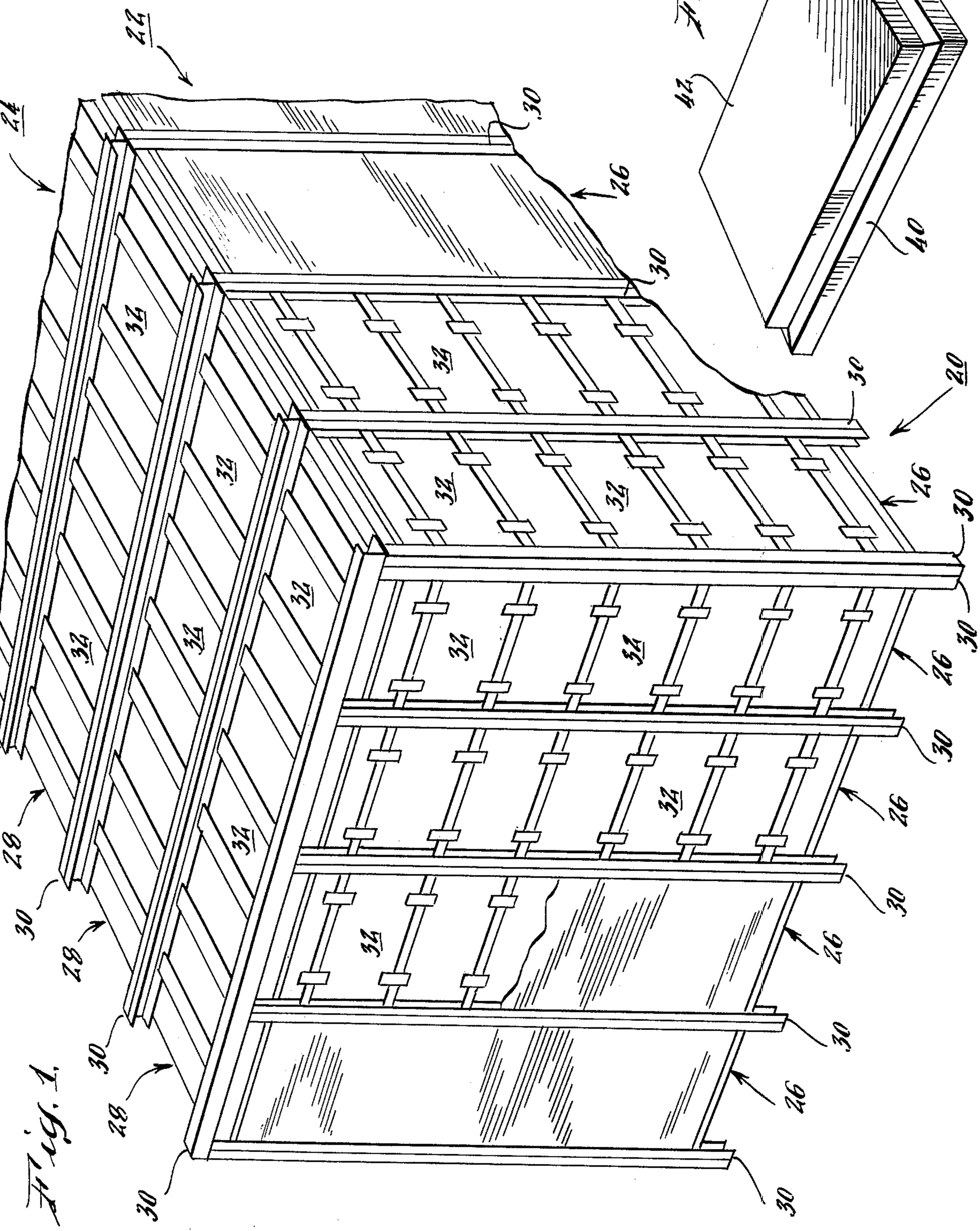

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Fig. 1.

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Fig. 2.

Fig. 3.

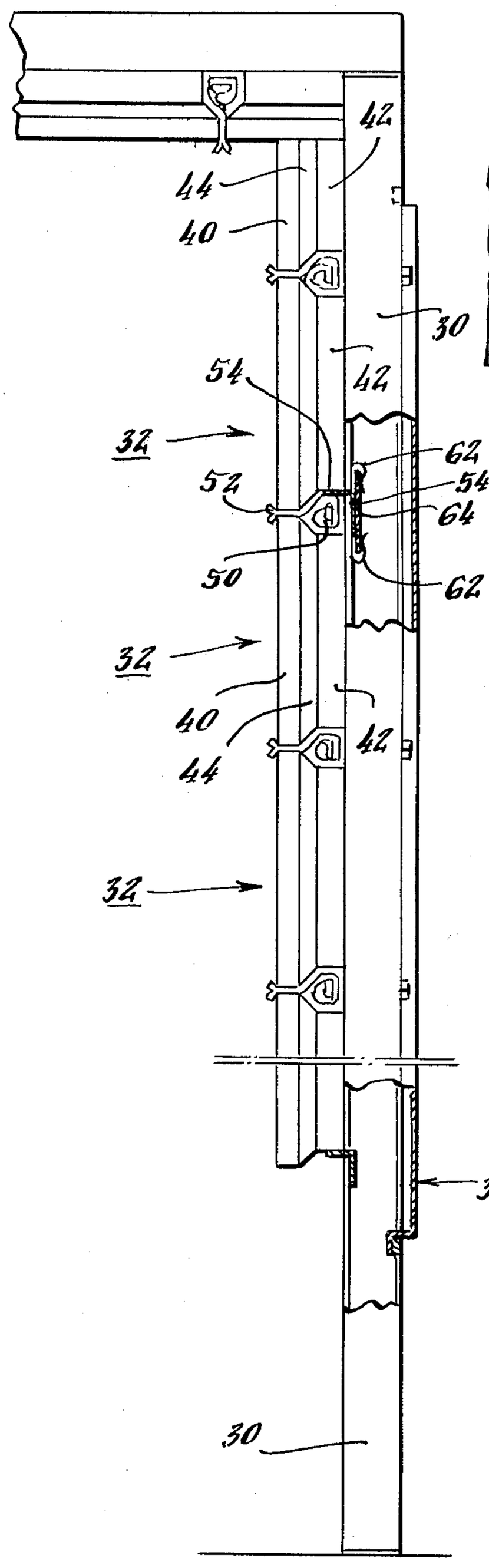
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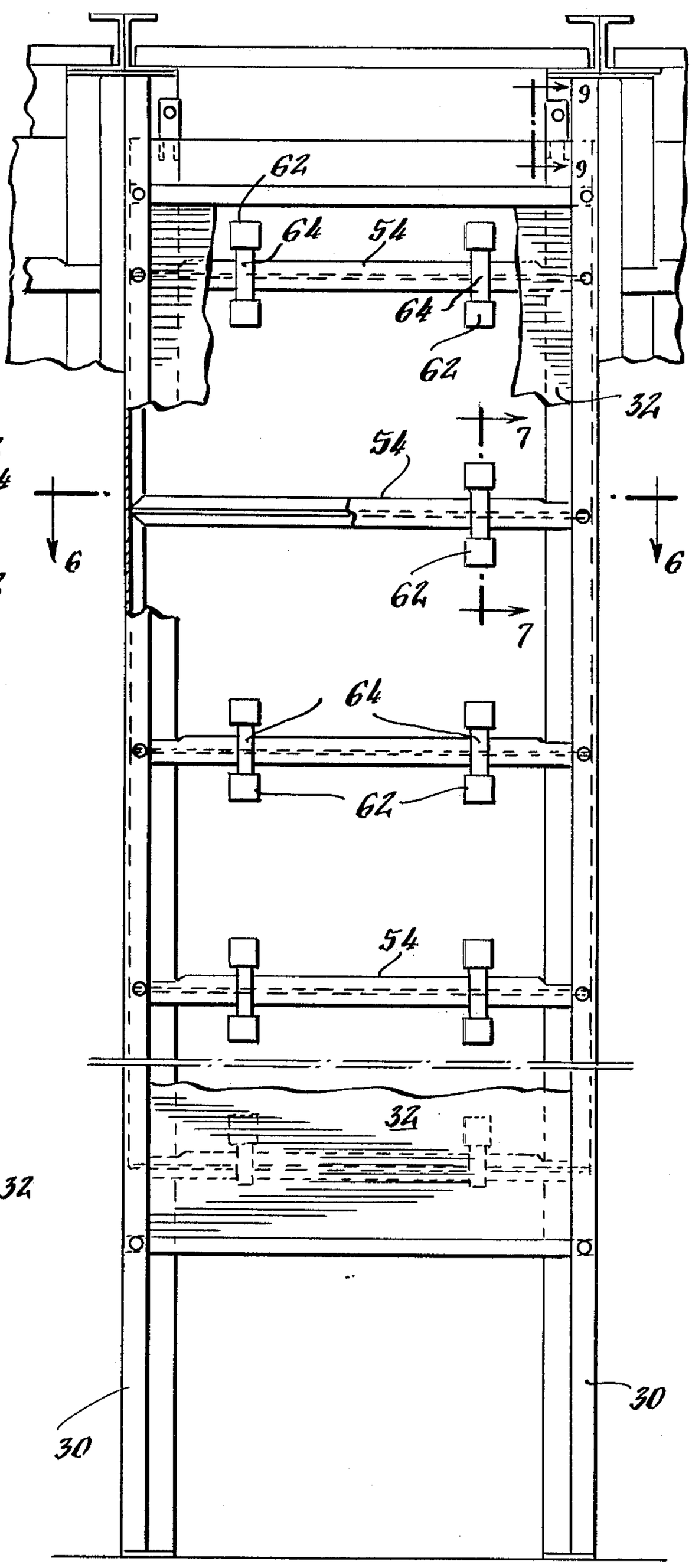
Fig. 4.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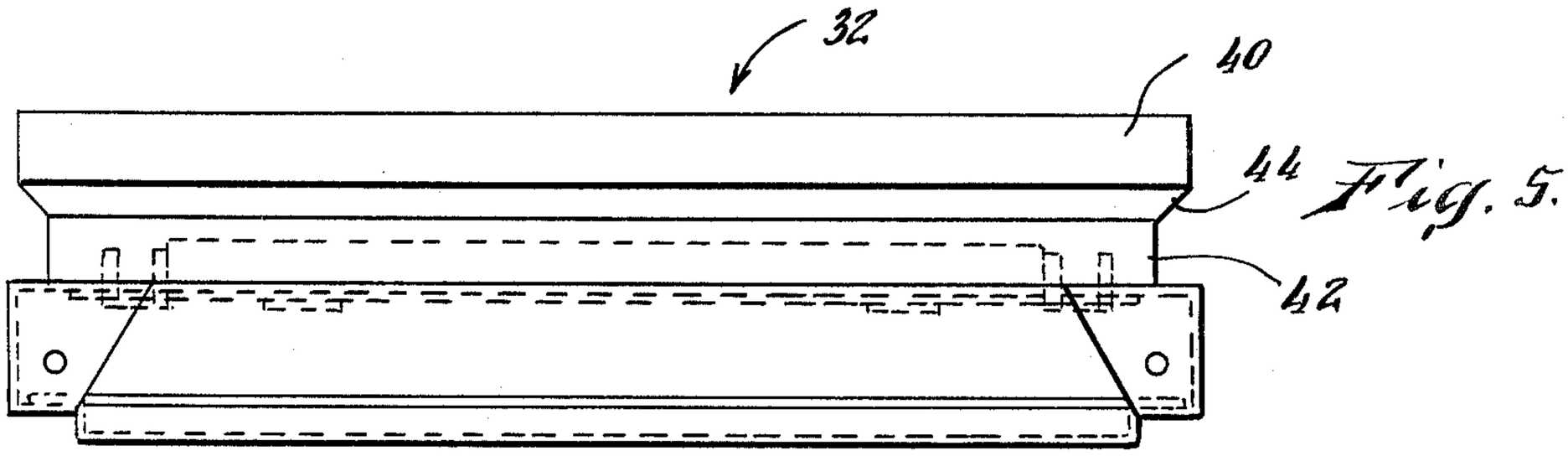

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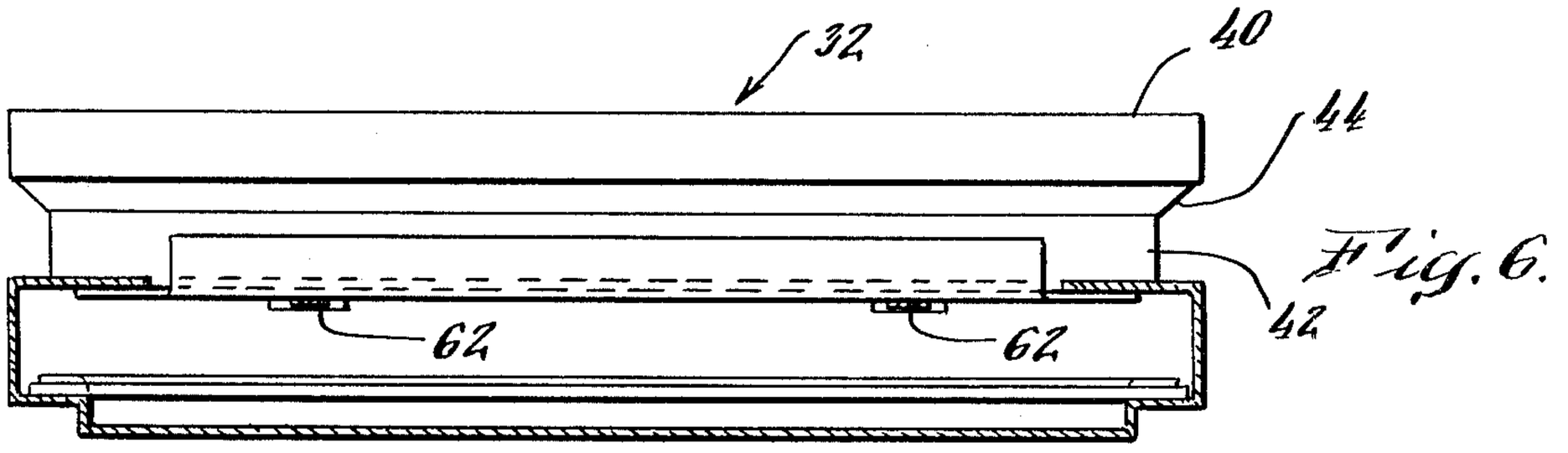


Fig. 6.

Fig. 8.

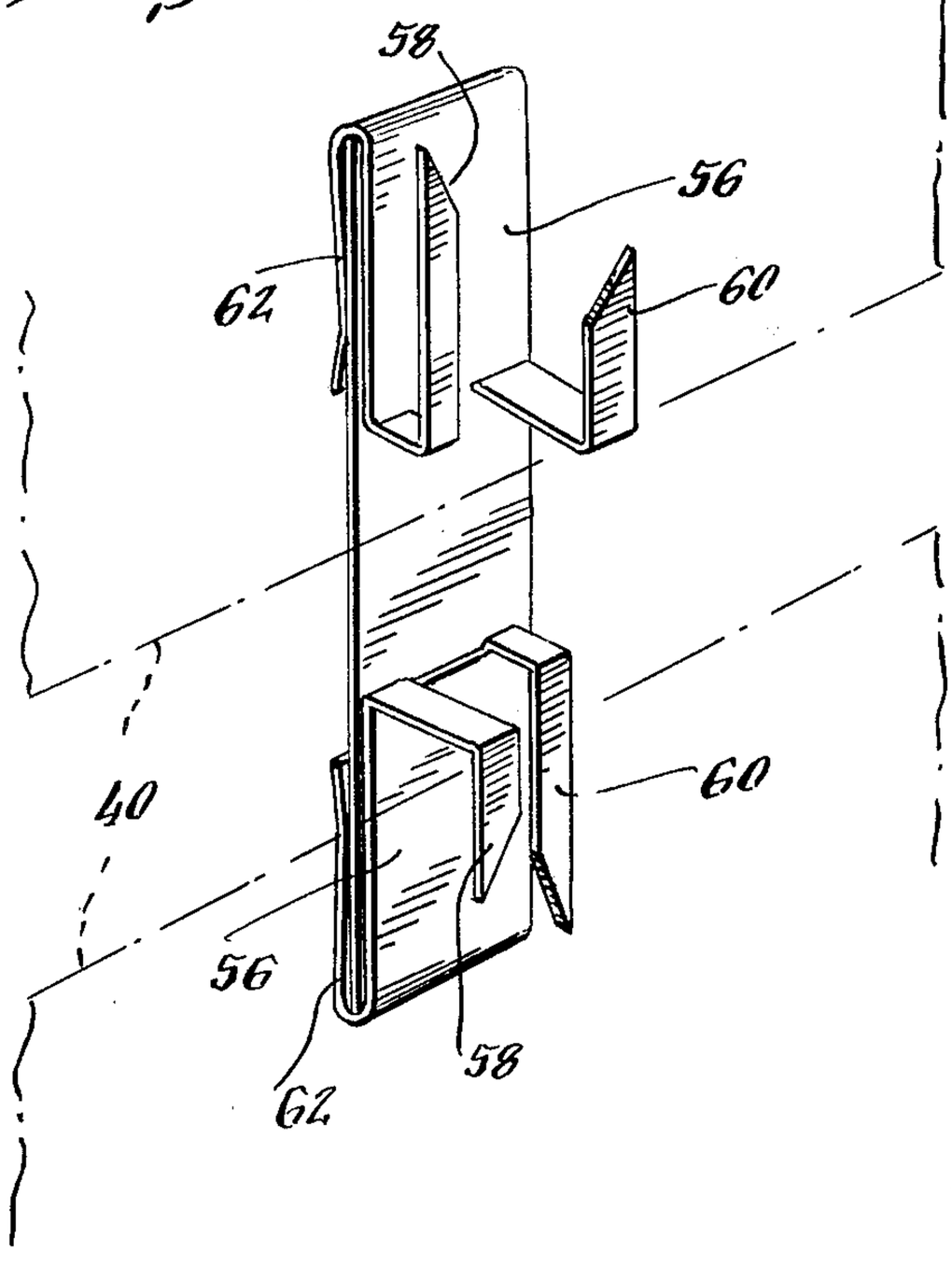


Fig. 7.

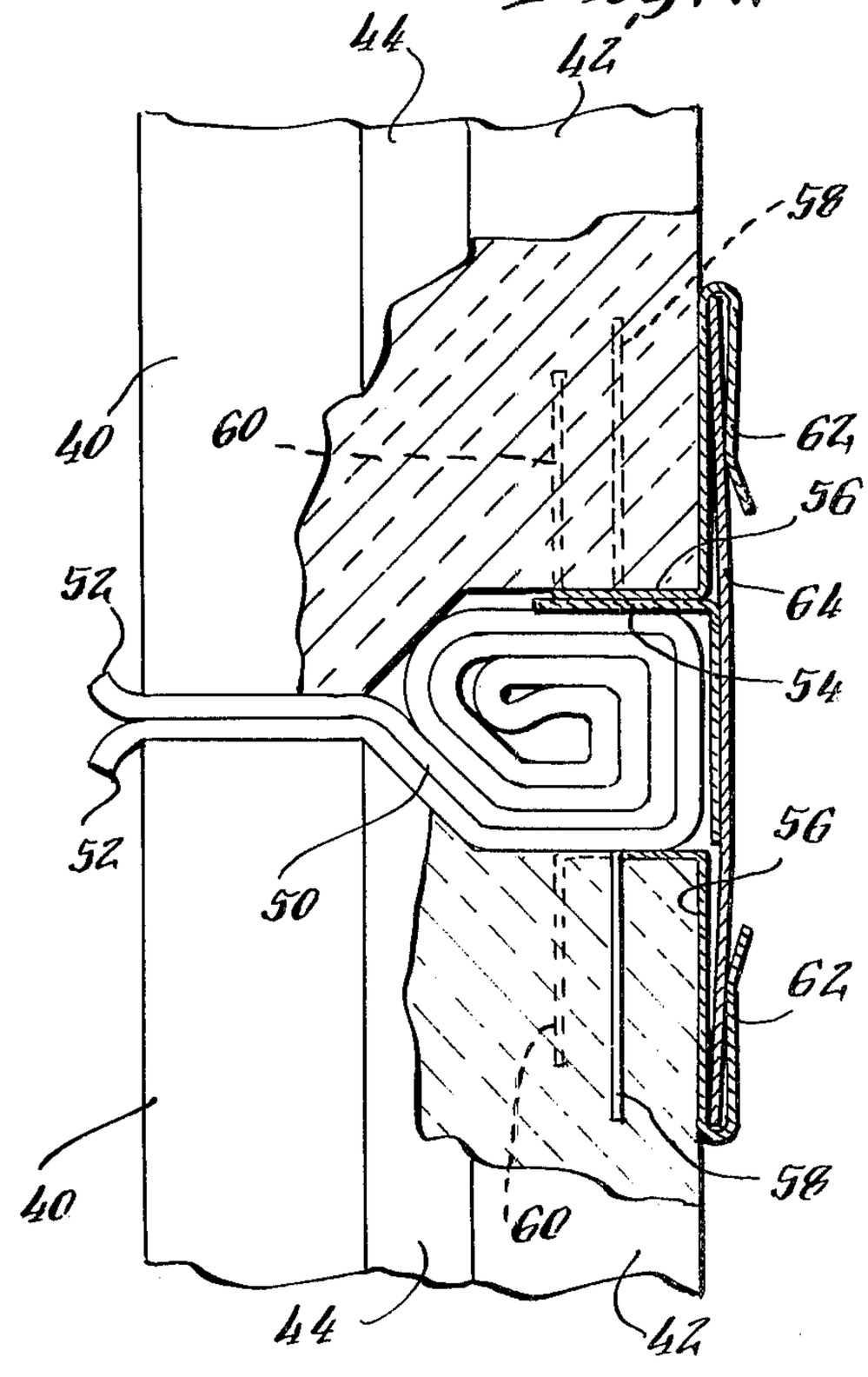


Fig. 9.

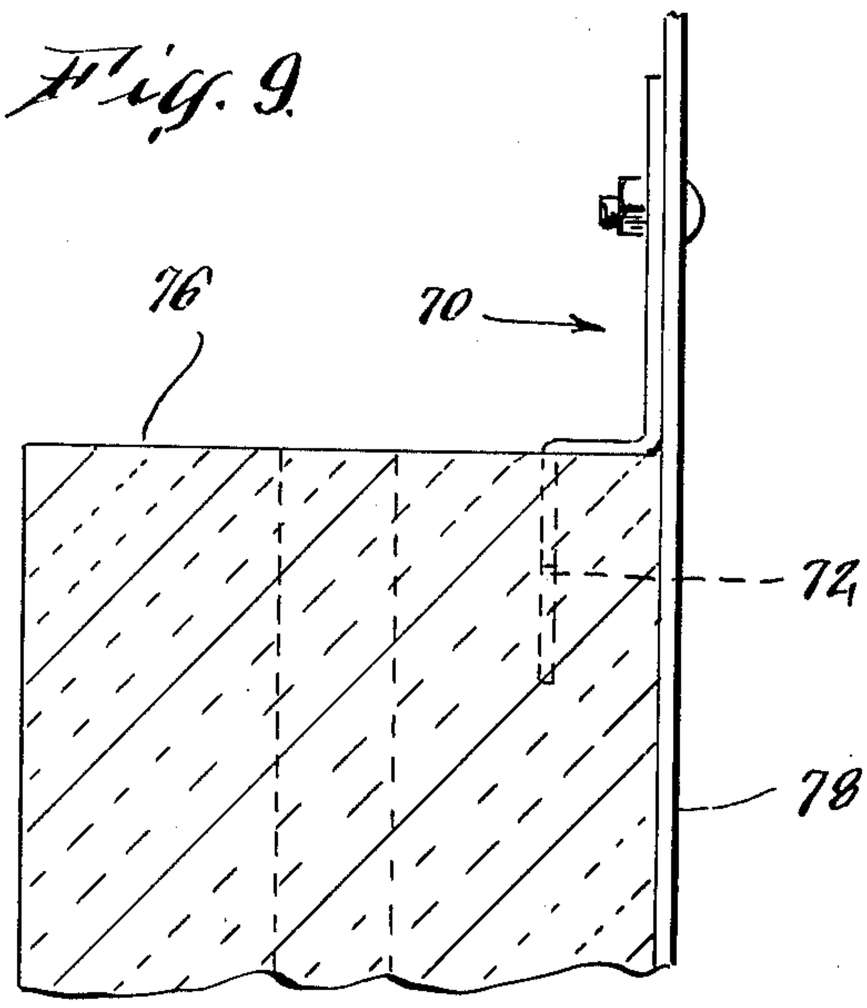
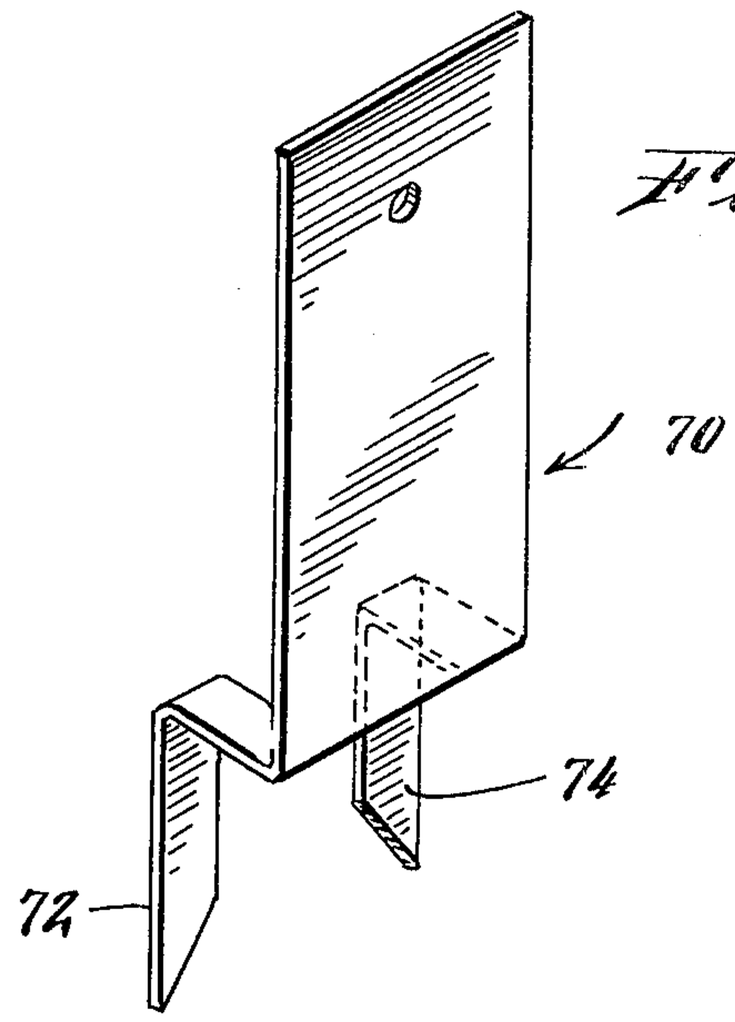


Fig. 10.



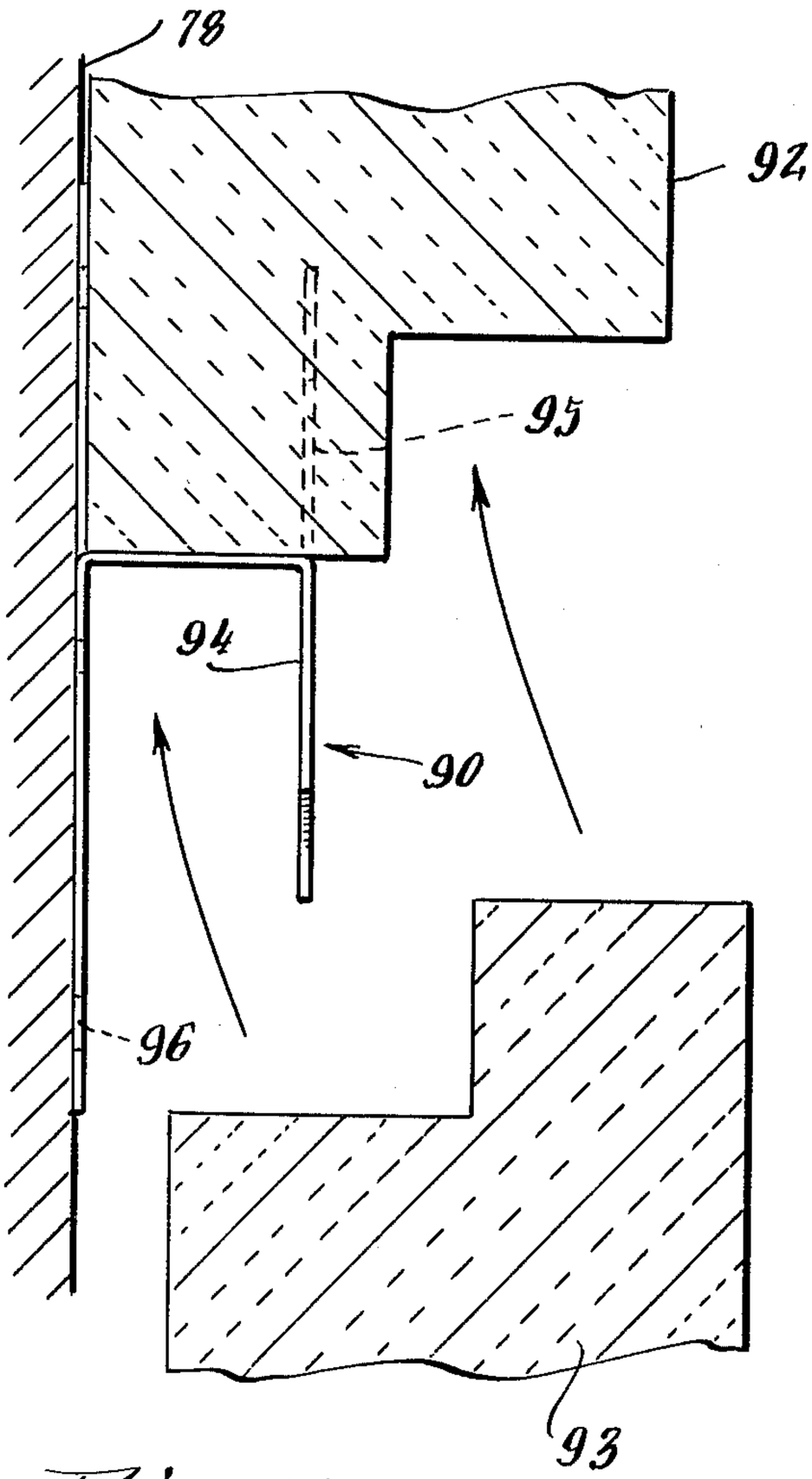
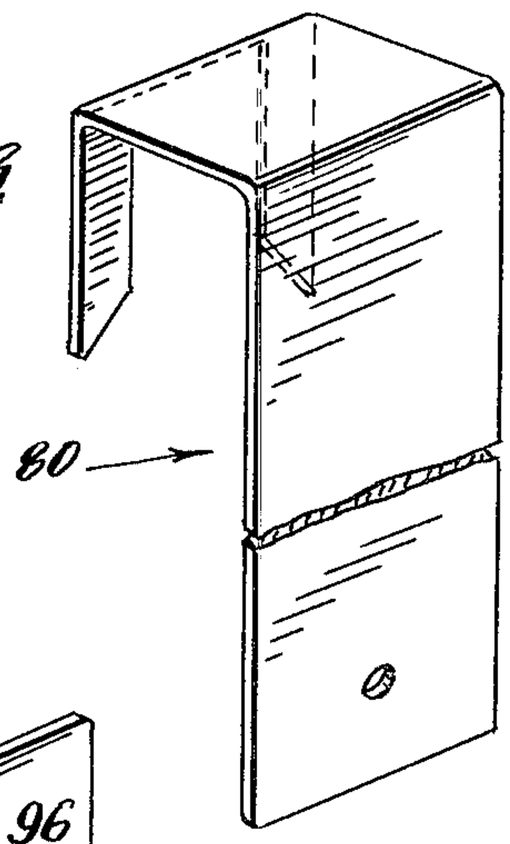


Fig. 11.

Fig. 13.



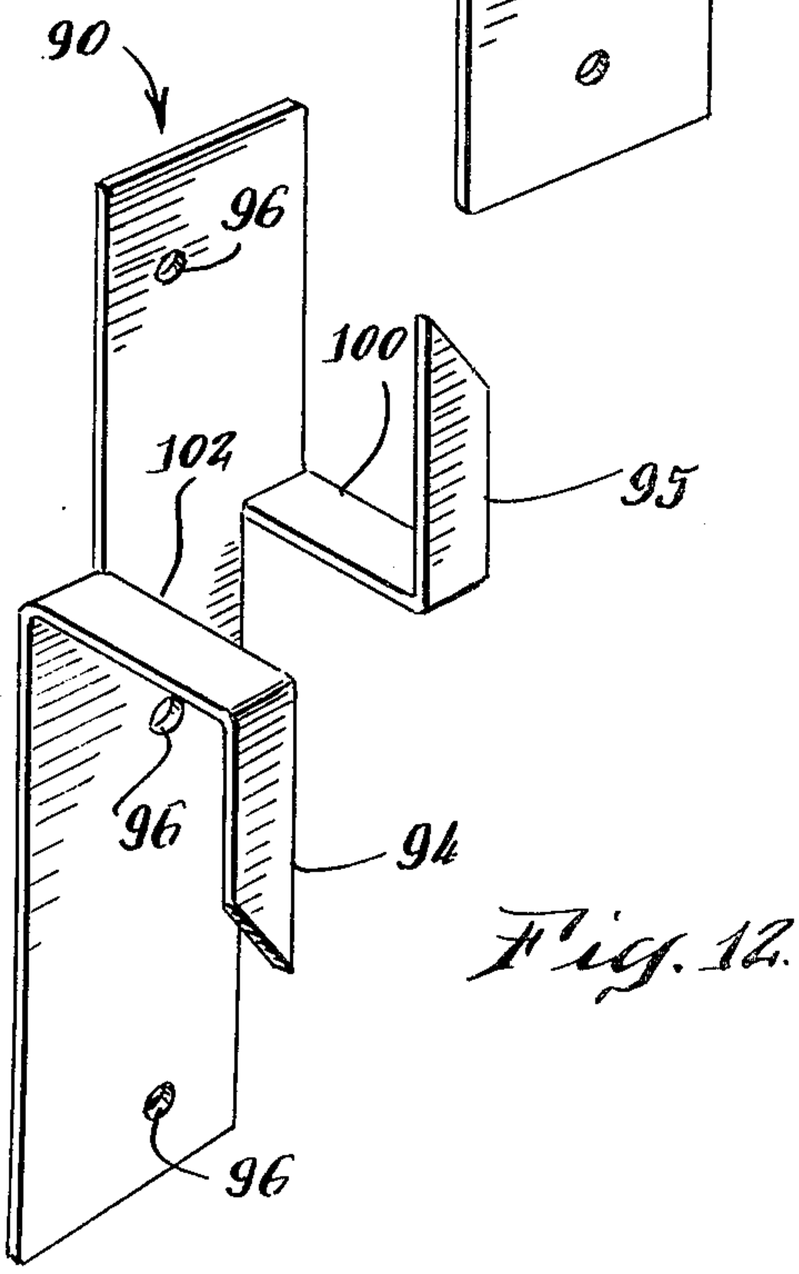


Fig. 12.

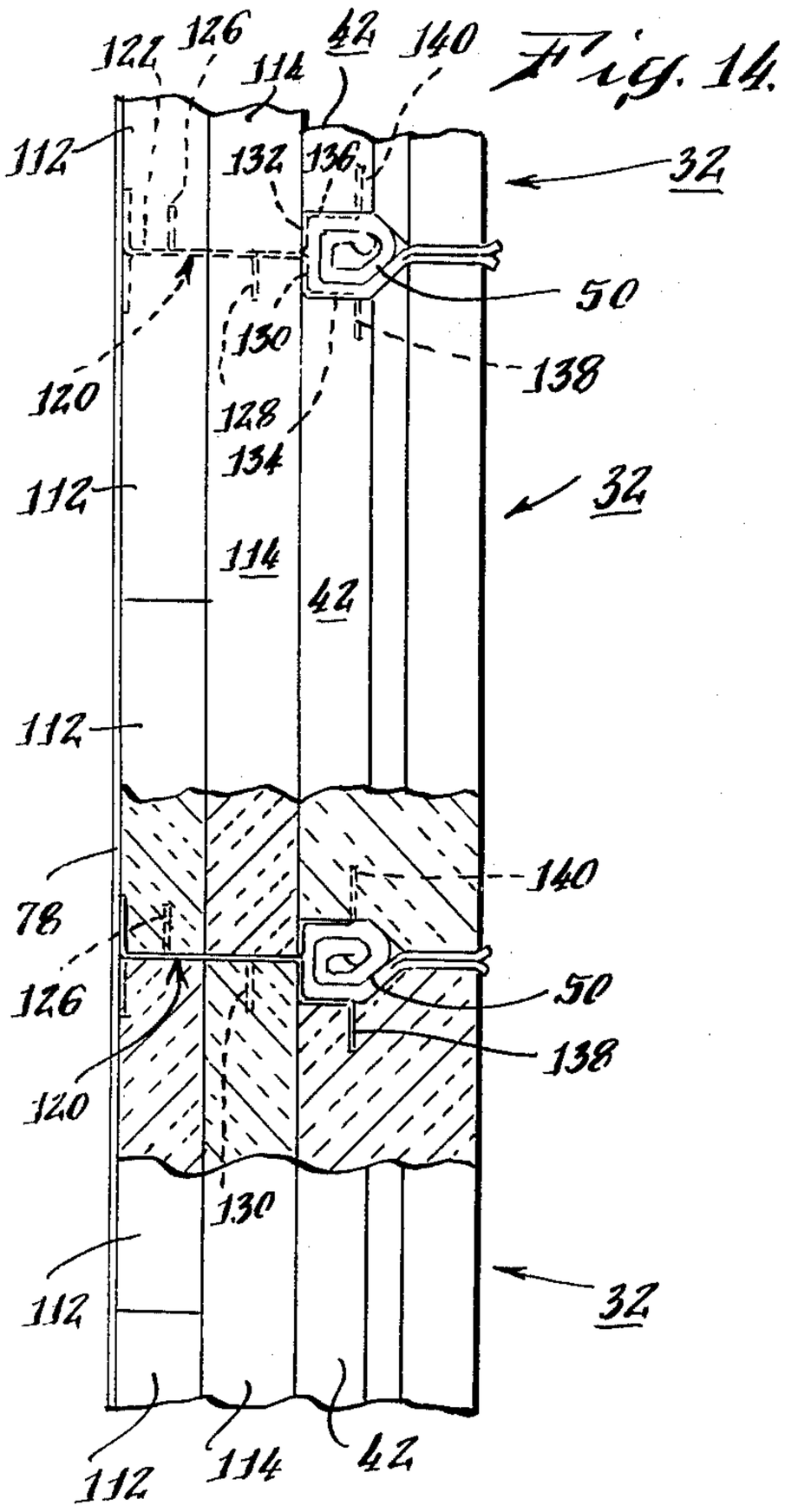


Fig. 14.

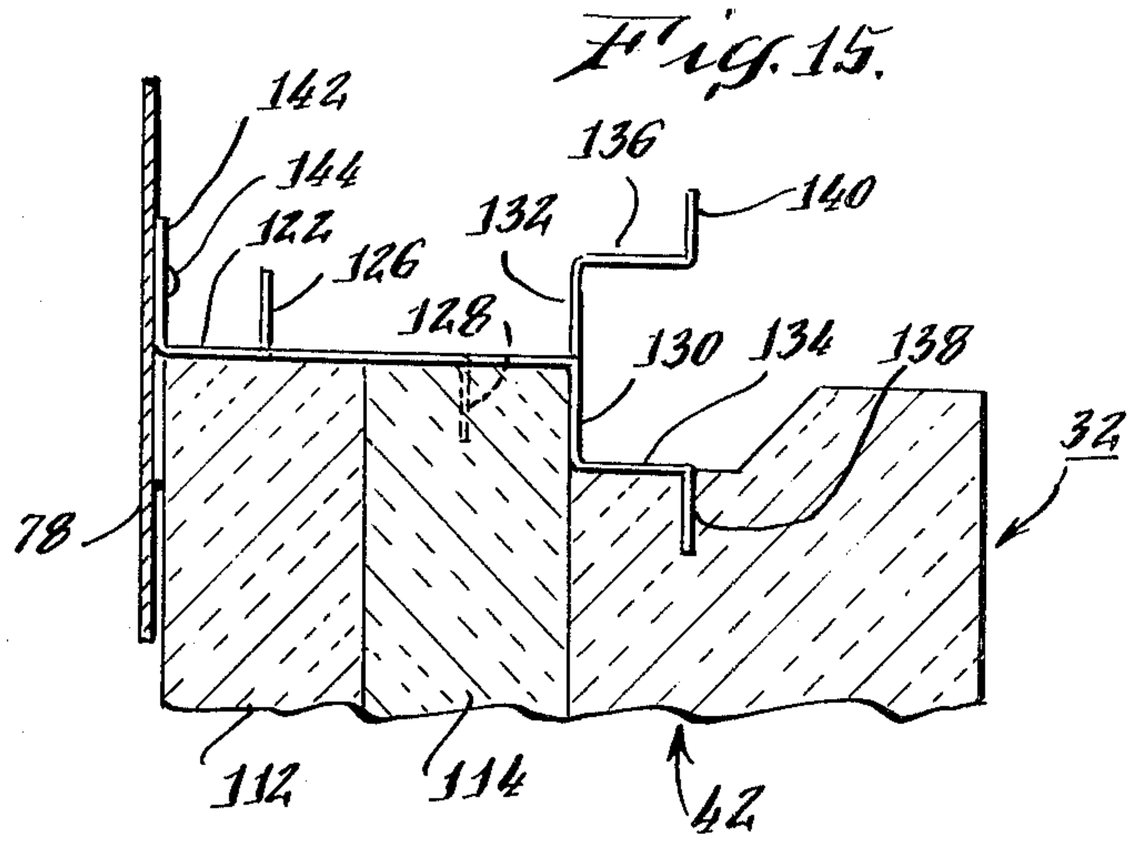
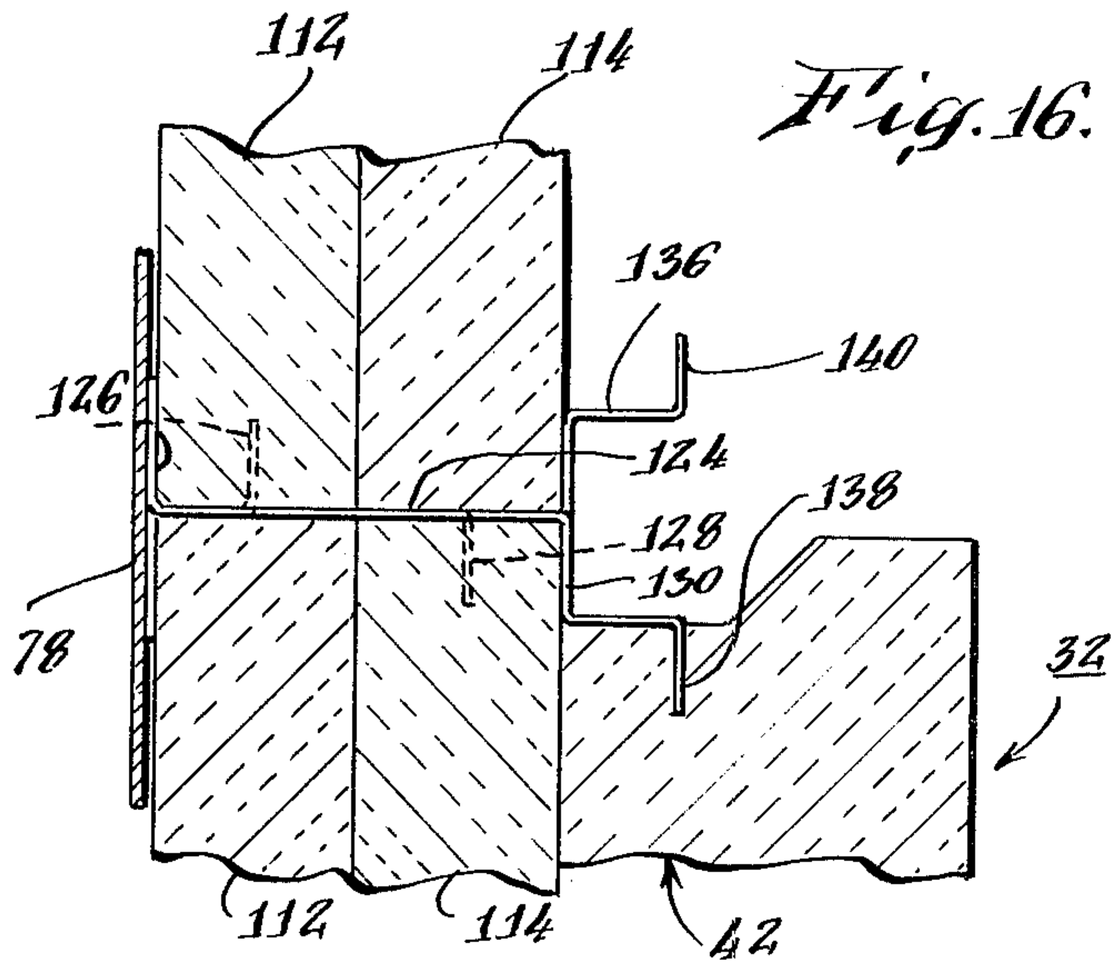


Fig. 15.



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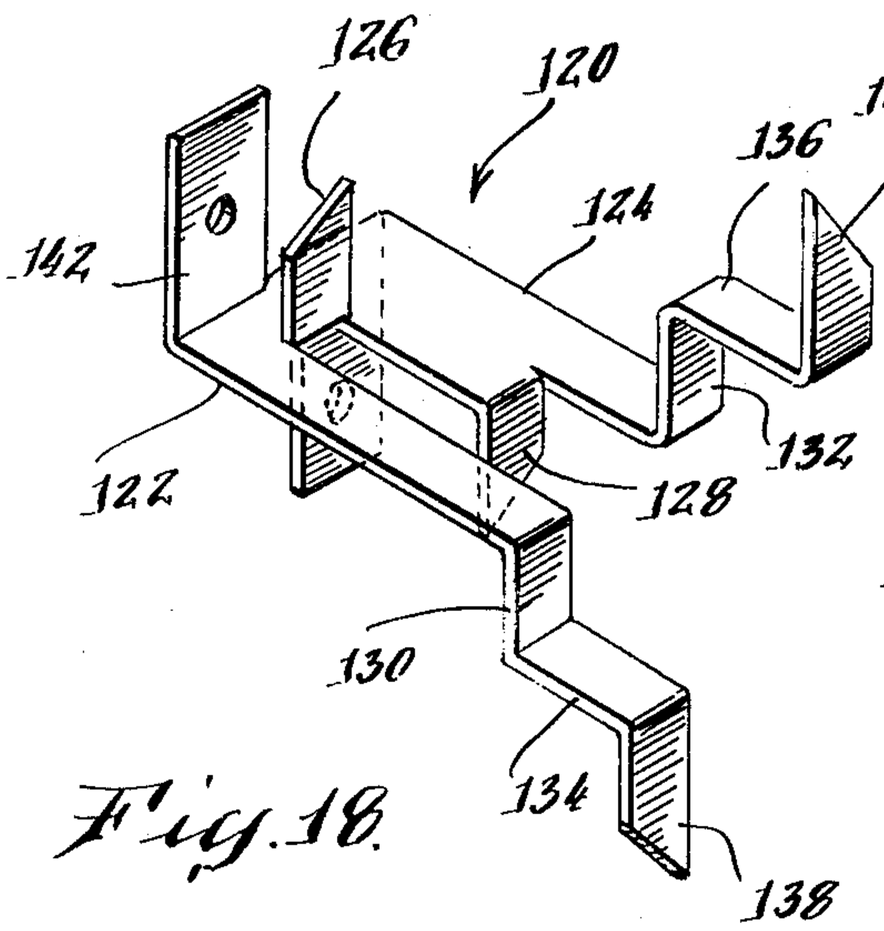

Fig. 18.

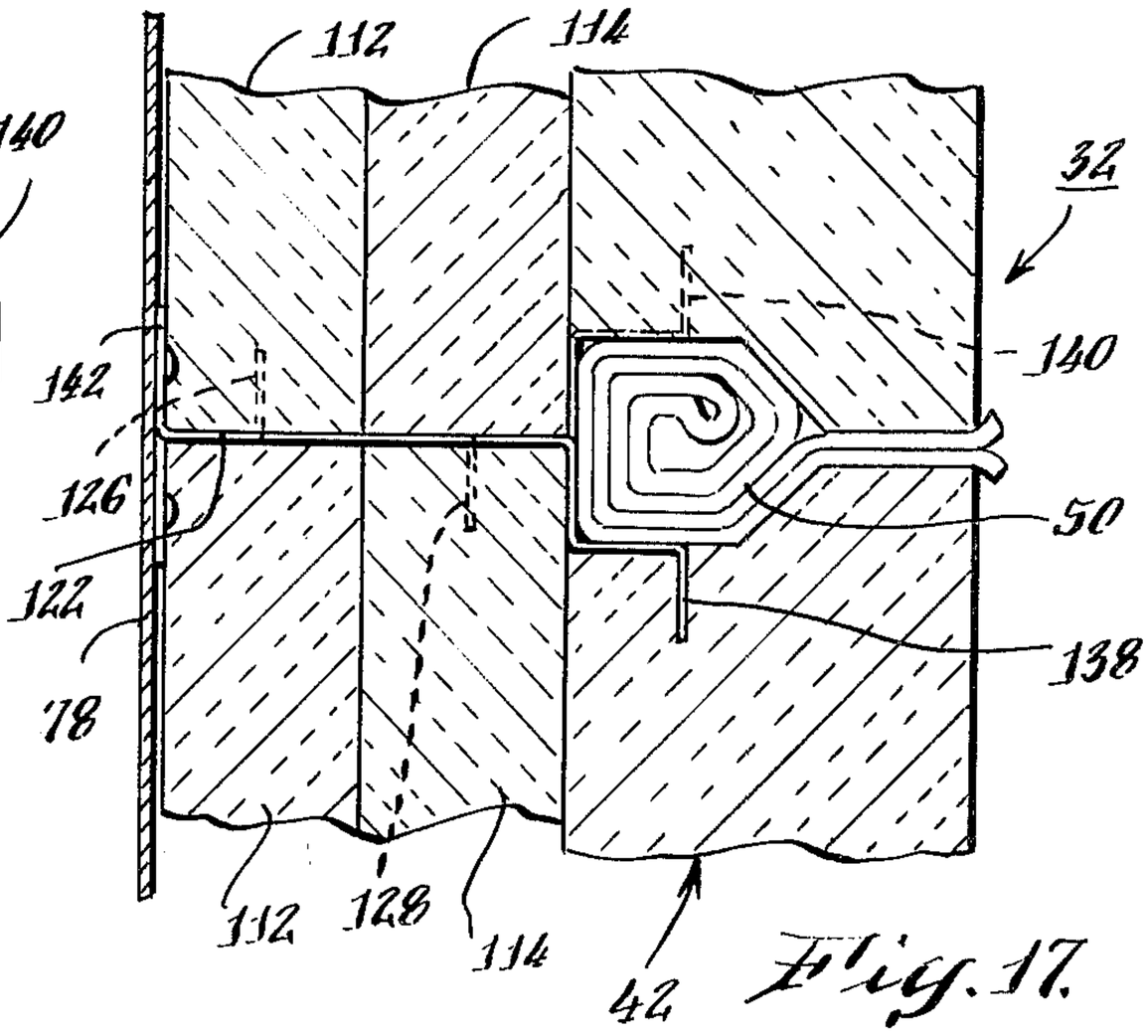

Fig. 17.

INDUSTRIAL FURNACE WITH CERAMIC INSULATING MODULES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to industrial furnaces used for example in heat treatment processing of material. More particularly, this invention relates to such furnaces employing ceramic fiber insulation in the form of lightweight modules, and specifically is directed to means for securing such ceramic insulation modules in the wall of a furnace, as well as to module configurations especially useful for such purpose.

2. Description of the Prior Art

The use of ceramic fiber modules to insulate high-temperature industrial furnaces is advantageous for various reasons, and especially because such construction affords significant savings in energy compared to the more conventional fire brick typically used for furnace linings. U.S. Pat. No. 3,500,444, issued to W. K. Hesse et al discloses one type of lightweight ceramic module, and describes a vacuum process for molding such a module from a liquid suspension of an inorganic refractory fibrous material. Such modules may have an electrical heating element embedded in situ during the forming process. Alternatively, the modules may be used solely for insulation purposes, as in oil or gas fired furnaces.

Such lightweight ceramic insulation modules do not possess great mechanical strength. For that reason, difficulties have been encountered in securing the modules in place in a furnace. The modules must be held securely in place during many years of use at high furnace temperatures, such as up to 2400° F. Moreover, the module arrangement should be capable of accommodating easy removal and replacement, as for maintenance and repair procedures required in high-temperature furnaces.

Accordingly, it is an object of this invention to provide improved means for mounting lightweight ceramic modules in an industrial furnace. A more specific object of the invention is to provide module arrangements and support means which are capable of reliably supporting a module in the wall of a furnace during long periods of high temperature conditions in the furnace. Other objects, aspects and advantages of this invention will in part be pointed out in, and in part apparent from, the following description considered together with the accompanying drawings.

SUMMARY OF THE INVENTION

In a presently preferred embodiment of the invention, to be described hereinbelow in detail, ceramic furnace wall modules rest upon and are vertically supported by horizontal cross-pieces fastened to vertical buck-stays which provide the mechanical means of structural support for the entire furnace. According to the invention in one of its aspects, the modules are held securely against lateral movement, while resting on the respective cross-piece, by means of special retainer clips inserted into the module interiors through the side surface of each module and fastened to adjacent structural elements.

According to yet other aspects of the invention, the ceramic furnace modules are generally rectangular blocks formed to provide a stepped side edge profile, i.e. being comprised basically of two integral but different-sized slab-like sections formed together as a single unit. The modules are positioned so that the larger sections face towards the furnace interior, and the smaller sections face outwardly. With the outwardly-facing sections being smaller in lateral size, an open region is created between adjacent outer sections and this region is filled with a rolled-up flexible ceramic blanket to prevent heat flow through what would otherwise be a straight-through channel.

According to still further aspects of the invention, L-shaped cross-piece module supports engage the lower edge surface of the smaller module sections to provide vertical support, and pronged retainer clips are inserted into those module sections and secured to adjacent structural elements to hold the modules firmly in place on the cross-piece supports. In other aspects of the invention, multi-layered insulation members are held in place by retainer clips having multiple prongs spaced apart horizontally and, for some applications, offset vertically.

Advantages of the invention include the capability of positively and securely holding ceramic insulating modules in place in a furnace wall, accommodating simple removal of a single module without disturbing adjacent modules, and providing for erection in situ quickly and economically.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing an industrial furnace insulated with lightweight ceramic modules in both its side walls and its roof;

FIG. **2** is a perspective view showing one of the ceramic modules with stepped configuration;

FIG. **3** is a vertical section through the furnace, showing one side wall and part of the roof;

FIG. **4** is an elevation view of one side wall panel, seen from the furnace exterior;

FIG. **5** is a plan view showing the upper end of the module panel;

FIG. **6** is a horizontal section taken along line **5-5** of FIG. **3**;

FIG. **7** is a detail vertical section showing the ceramic blanket in place between two ceramic modules;

FIG. **8** is a perspective view of a retainer clip as used with the modules shown in FIG. **6**; and

FIGS. **9** through **18** show still other retainer clip arrangements.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. **1**, there is shown an industrial furnace **20** with its side walls generally indicated at **22** and its roof generally indicated at **24**. The side walls and roof both are formed of side-by-side sets of panels **26** and **28**. Each side panel **26** comprises a pair of vertical buck-stays **30** providing rigid support for a stacked group of generally rectangular insulation modules **32** constituted and produced as described hereinabove. Each roof panel **28** similarly comprises horizontal buck-stays **30** from which are suspended a corresponding group of insulation modules **32**.

The modules **32** (see also FIG. **2**) may be 36″ wide by 18″ high by 5″ deep, with the buck-stays **30** spaced correspondingly. The panels **26** and **28** form the basic standard side wall and roof components for furnaces of various sizes, in multiples of the nominal module width and height (e.g. 36″×18″). Typically these panels are

factory assembled and pre-wired. Field erection then merely requires that the panels be bolted together and inter-panel insulation emplaced as described hereinafter. Such an arrangement particularly is advantageous for furnaces too large to be shipped completely factory assembled.

As may be seen particularly in FIGS. **2** and **3**, each module **32** is a generally rectangular block presenting a stepped configuration, i.e. it is formed to include a full-sized rectangular inner slab-like section and a set-back outer slab-like section **42** of slightly smaller lateral dimensions defining a rectangular face approximately geometrically similar to that of the inner section **40**. The stepped region of joinder between the two sections **40**, **42** comprises, in the preferred embodiment, a truncated pyramidal section **44** which provides a taper angle making a generally smooth sloping transition between the two slab-like sections **40** and **42**.

The modules **32** are mounted in the panels **26** in side-by-side fashion. The region between adjacent outer sections **42** is filled by a rolled insulation blanket **50** which serves to block off what otherwise would be a high heat-loss channel resulting from a straight through joint. This blanket preferably is formed of inorganic fibrous ceramic material, like that used in the ceramic modules **32**, but without binding agents as employed in the liquid slurry used to make the modules rigidly shaped-retaining. The blanket thus is sufficiently flexible and compressible so that it can easily be rolled into a relatively tightly compressed shape, as shown in the drawings. Similarly rolled blankets are inserted between the side edges of the outer sections **42** of the ceramic modules in adjacent panels **26**.

The rolled blankets **50** are sufficiently resilient so that, after compression and insertion into the regions between the modules **32**, the blanket material tends to expand so as to fill the entire adjacent space, thereby to help compensate for slight size variations encountered in production. Also due to their resilient compressibility and springiness, these blankets tend to compensate for the shrinkage in size of the ceramic modules **32** which occurs when the furnace is fired the first few times; that is, the blankets resiliently expand to fill the void created by such shrinkage. In accordance with a further aspect of this embodiment, the tails **52** of the rolled blanket are arranged to protrude a small distance (e.g. an inch or so) into the furnace interior. This tail material thus is available subsequently to be stuffed into the parting between the modules, should an intermodule separation of beyond-normal size occur due for example to unusually high furnace temperatures in a given application.

Referring now to FIG. **7**, the modules **32** rest on cross-support angle members **54** of inverted L-shape (as seen in cross-section), and so arranged that the flat horizontal surface of each cross-angle member provides support for the outer section **42** of the module immediately above. The cross-support angle members are fastened at their ends to the buck-stays **30** of the corresponding multi-module side wall panel **26**.

Inserted into the side edges of the outer (smaller) sections **42** are retainer clips **56** of a stainless steel comprising a heat-resistant alloy and having pairs of sharp prongs or spikes **58**, **60** (see also FIG. **8**). Spring clasps **62** are integrally formed as part of these retainer clips, and receive and grip under spring tension respective rigid steel lock-bars **64**. These lock-bars extend across the corresponding cross-angle member **54** and serve to secure the modules **32** firmly in fixed position horizontally with respect to the cross-angle members. Thus the modules are supported vertically by the cross-angle members, through direct engagement therewith, and are secured horizontally by the retainer clips which interconnect with a cross-angle member by means of the corresponding lock-bar.

The prongs or spikes **58** and **60** of the retainers **56** are offset laterally a substantial distance. Thus the respective planes of the insertion cuts developed by the blade-like spikes are separated a corresponding horizontal distance within the ceramic modules **32**. This separation tends to lessen any chance that a split or effective delamination will develop in the ceramic material as a result of stress across the cleavage planes of the spikes.

Because of the extremely high furnace temperatures commonly encountered, e.g. up to 2400° F., there possibly could be degradation of a module retainer due to exposure to high temperatures. However, such a problem is avoided with the present design wherein the prongs **58**, **60** are spaced a limited distance in from the outer surface of the module. It has been found that such limited spacing is fully effective in providing desired module retention characteristics, preventing displacement of the module as required for proper furnace performance. Preferably, this spacing between retainer prong and module outer surface should be less than one-half of the module thickness. With the quite steep temperature gradients within the module, the retainer prong, and the adjacent retainer support arm connected thereto, will be at a sufficiently low temperature to prevent damage to the material of the retainer clip.

A further important advantage of the above-described arrangement is that it provides for ready replacement of any of the ceramic modules **32**, for example in the event of damage to a module from any cause. To replace a module, the respective locking bars **64** are removed, both at the lower and upper edges of the module. Then the module is pushed inwardly towards the furnace interior, initially sliding along the upper surface of the cross-angle member **54**, to a position where it can be grasped from within the furnace interior and removed. Installation of a replacement module follows the reverse procedure.

FIGS. **9** and **10** show another module retainer clip **70** having a pair of symmetrical prongs **72**, **74**. As shown in FIG. **9**, such a retainer clip can be used to secure the upper end (or side) of a ceramic module **76** to the inside surface of the steel shell **78** of a gas-tight furnace. For example, such construction is employed in atmosphere furnaces using combustible gases which protect the work against oxidation, or in material treating such as carburizing or carbo-nitriding. FIG. **13** shows another such retainer clip **80**, useful for securing the end or side of a module to a steel shell. Both clips can be fastened to the furnace shell by bolts, by welding, or by explosively-driven fasteners.

FIGS. **11** and **12** show still another retainer clip arrangement **90** for securing to a furnace shell **78** a pair of adjacent ceramic modules **92**, **93** of ship-lap configuration, i.e. blocks having complementary offset stepped profiles along their adjoining side edges, to provide for close mating without a straight-through parting line. This retainer **90** is formed with a pair of side-by-side oppositely-extending prongs **94**, **95**, which pierce the side edges of the respective modules to be embedded therein. The retainer is adapted to be secured to the inner surface of the furnace shell by weldments formed through one or more weld holes **96**.

This arrangement provides for rapid assembly of the modules as lining for the furnace, and further provides for secure gripping of the modules to hold them firmly in place. Advantageously, the prongs are supported by separate respective arms **100, 102** which preferably are relatively narrow, thereby to minimize the conduction of heat from the region of the prongs back to the furnace shell.

FIGS. **14–18** illustrate a retainer clip arrangement for holding multiple-layer insulation in place. The application disclosed is for securing insulation blocks to a furnace shell **110**, either for new construction, or for re-lining old furnaces. One advantage of multiple-layer insulation arrangements is that relatively inexpensive insulation material, such as vermiculite, can be used for the cooler outer and intermediate blocks as shown at **112, 114**, while high-performance but more costly ceramic modules **32** can be used as the hotter inner block where the requirements are more severe. In one particular installation, the outer and intermediate blocks **112, 114** were 2″ thick, and the inner module **32** was 5″ thick.

To secure such multiple insulation layers in place, the embodiment of FIG. **14** incorporates a multiple-spike retainer clip **120** (shown in detailed perspective in FIG. **18**). Each such clip includes two horizontal support arms **122, 124** extending out between the first vertically-stacked outer insulation blocks **112**. At about the horizontal mid-point of this first set of blocks, an upwardly-facing spike **126** is formed by a bent-up half-width portion of one arm **122**, and is embedded in the upper outer block **112**. At a further horizontal point, a portion of the other arm **124** is formed downwardly into a second spike **128** embedded in the lower intermediate block **114**.

The remaining portions of the arms **122, 124** continue horizontally to the inner face of the second stack of blocks **114**, where the arms are respectively formed with upwardly and downwardly extending sections **130, 132**. These latter sections have at the ends thereof corresponding horizontal sections **134, 136** supporting respective spikes **138, 140** facing up and down respectively. These latter spikes are embedded in the vertically-spaced-apart module sections **42** (generally as in the arrangement of FIG. **7**). In the region between the adjacent spaced-apart module sections **42** is a rolled compressed blanket **50**, as previously described.

FIGS. **15–17** show the sequence of events in installing the multiple layers of insulation. First, the insulation blocks **112, 144** and the module **32** are placed in position, as by being impaled upon spikes at their lower edges (not shown). The downward spikes of the retainer clip **120** then are inserted into the corresponding block and into the outer module section. The upper portion of the vertical support plate **142** of the retainer then is fastened to the furnace shell **78**, as by welding **144** or the like. The upper blocks **112, 114** then are placed in position, with the outer block **112** impaled upon the corresponding upwardly-pointing spike. Then the rolled ceramic blanket **50** is positioned as shown, and the upper module **32** is placed down onto the upwardly facing spike **140**. This process then continues with the next higher layer of blocks and modules, and so on.

Although several preferred embodiments have been described hereinabove in detail, it is desired to note that this is for the purpose of illustrating the invention, and should not be considered necessarily limiting of the invention, since it is apparent that those skilled in the art will be able to modify the invention in many ways to meet the requirements of different applications. For example, with reference to the FIG. **14** arrangement, if there is no requirement for the additional insulation blocks **112, 114**, the ceramic modules **32** can be secured directly to the furnace shell **78** by retainer clips like that of FIG. **18**, but wherein the arms **122, 124** and the associated spikes **126, 128** are omitted. In such a modified retainer, the horizontal arms **134, 136** could connect directly to a vertical-support plate **142** to be fastened to the furnace shell. Still other modifications within the scope of the invention will be apparent to those skilled in this art.

What is claimed is:

1. An industrial furnace used for material heat treatment and the like, comprising:

a plurality of ceramic fiber insulating modules positioned side-by-side;

each of said modules including an inner section presenting a face to the interior of the furnace;

the side edges of said inner module sections being mated together in close proximity to establish an effectively continuous insulation area;

each of said modules further including outer sections integral with said inner sections but having smaller lateral dimensions to form set-back side edges;

flexible and compressible insulating material in the regions between adjacent set-back edges and at least substantially filling the spaces of said regions; and

support means securing said modules in position.

2. Apparatus as claimed in claim **1**, wherein said ceramic fiber insulating modules are arranged in side-by-side panels each having elongate support elements extending alongside of the group of modules making up the panel; and

means securing said group of modules to the respective support elements.

3. Apparatus as claimed in claim **1**, wherein said inner and outer module sections are parallel block-like members generally rectangular in configuration and presenting planar faces to the furnace interior and to the outside.

4. Apparatus as claimed in claim **3**, wherein said modules include an intermediate section between said inner and outer sections, said intermediate section presenting a smoothly tapering side surface joining the side edge surfaces of said inner and outer sections.

5. Apparatus as claimed in claim **1**, wherein said flexible and compressible insulating material comprises a rolled blanket-like element.

6. Apparatus as claimed in claim **5**, wherein a portion of said blanket-like element extends between the side edges of adjacent inner module sections.

7. Apparatus as claimed in claim **6**, wherein said blanket-like element includes a tail portion extending a short distance beyond the inner face of the adjoining inner module section, into the furnace interior.

8. Apparatus as claimed in claim **1**, wherein said modules are arranged to form a side wall of the furnace;

said support means comprising rigid elements supporting the modules vertically;

a plurality of retainer clip means each comprising at least one sharp spike inserted into horizontal side edges of said outer module sections;

said retainer clip means including elements integral with said spikes and extending horizontally outwards therefrom to the outer faces of said modules; and

means interconnecting said retainer clip elements and said support means rigid elements to hold the modules secure against horizontal movement.

* * * * *